Propagation of Precipitation over Mediterranean Basin

Amita V. Mehta [1], Eric A. Smith [2], and Song Yang [3]

[1] NASA/Univ. of Maryland Baltimore County Joint Center for Earth Systems Technology (JCET), 613.1 NASA/GSFC, Greenbelt, MD 20771 [amita@radar.gsfc.nasa.gov]

[2] NASA/Goddard Space Flight Center, Laboratory for Atmospheres (Code 613.1), Greenbelt, MD 20771 [eric.a.smith@nasa.gov]

[3] I.M. Systems Group & Center for Satellite Applications and Research (STAR)/NESDIS/ NOAA, Camp Springs, MD 20746 [song.2.yang@noaa.gov]

Rationale:

Mediterranean basin (MB) generally acts as a source region of atmospheric water vapor (evaporation dominates over precipitation), but as found in the ERA-40 reanalysis, its strength varies on inter-annual and longer time scales **(Figure 1)**.

A number of studies document that seasonal rainfall over MB is found to be mostly associated with synoptic cyclonic disturbances and mesoscale rain systems occurring on 2-8 days time scale (e.g. Lionello et al., 2006).

These cyclonic disturbances are detected and documented generally from either NCEP or ECMWF model analysis based on sea level pressure, geopotential heights, and winds (e.g. Homar et al., 2007, Trigo A., 2006). Precipitation associated with these cyclones, however, is not always resolved in the model analysis.

Most published studies concerning observed precipitation climate of MB is based upon data from either raingauge sites situated over land, most over southern Europe and some over northern Africa **(Figure 2)**.

There is little understanding of climatological behavior of observed precipitation over Mediterranean region available from various global-decadal scale satellite datasets.

Objective:

Provide an improved description of the climatological features of MB precipitation using the Tropical Rainfall Measuring Mission (TRMM) data products including Space-time distribution of monthly precipitation and seasonal characteristics of mesoscale rain systems.

Data and Analysis:

TRMM Blended Rain Products (3B42, 0.25° grid and 3 hourly).

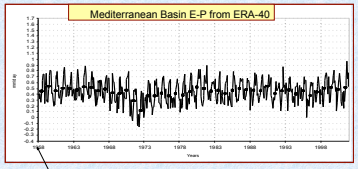
TRMM Official Rain Products (2A25, 2B3 5km and instantaneous).

Domain : 5°W-40°E and 28°N-48°N (Southern Europe, Mediterranean sea, North Africa).

Mediterranean Basin: 32°N-44°N , 16.5°E used as the boundary between East and West Mediterranean basin.

Pentad-mean rain rates (RR) formed from the TRMM products for January 1998-July 2007.

There is a general agreement between various TRMM products **(Figure 3)**.
Subsequent results shown here are based on TRMM 3B42 (Mehta and Yang, 2008).



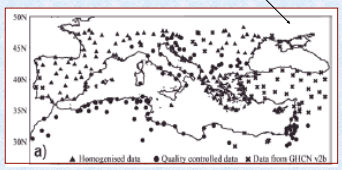


Figure 1 and Figure 2

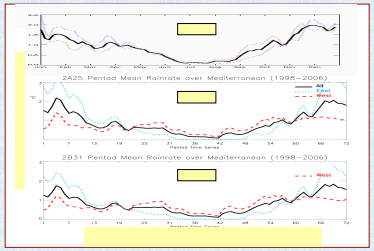


Figure 3

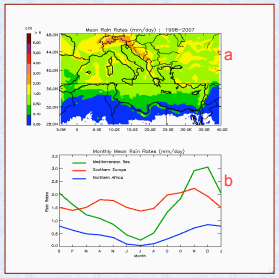


Figure 4

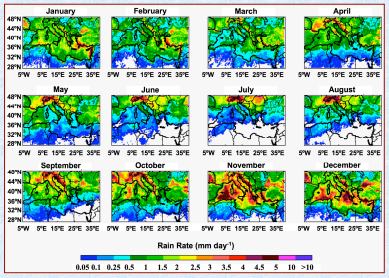


Figure 5

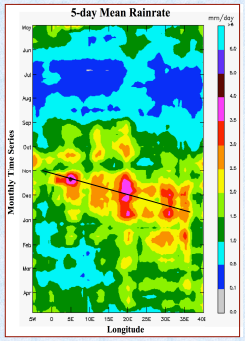


Figure 6

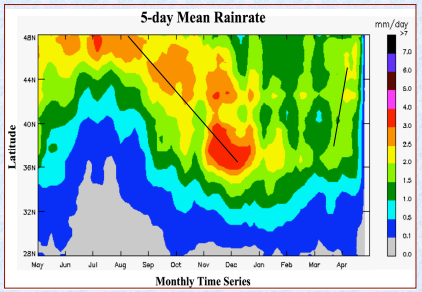


Figure 7

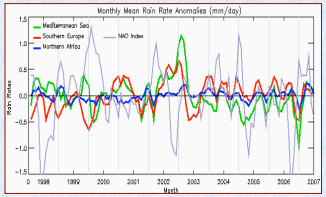


Figure 8

Summary:

There are substantial regional differences in rainrates over the Mediterranean Basin (MB). The maximum rainfall (3-5 mm day-1) occurs over the mountain regions of Europe, while the minimum rainfall is over north Africa (~0.5 mm day-1). Over the Mediterranean Sea, an average rainrate of ~ 1-2 mm day-1 is observed with a maximum rainrate found over the western Mediterranean Sea **(Figure 4a)**.

The main rainy season over the Mediterranean Sea extends from October to March, but maximum rainfall occurs during November-December. During the rainy season western Mediterranean Sea receives ~20% larger rainfall compared to eastern Mediterranean Sea. Over southern Europe, there is a bimodal rain pattern with spring and autumn seasons having maximum rainfall **(Figure 4b and Figure 5)**.

Starting in October, the rain systems first emerge over the western MB, and continue to move eastward up to 35°E in January. The rain activity subsides over the western MB after January, but persists until March in the eastern MB. Although MB is located south of the Atlantic mid-latitude storm zone, observations show that the upper level circulations related to Atlantic storms help trigger cyclonic disturbances with hazardous winds and rainfall over MB (Lionello et al., 2006). These disturbances are known to enter MB from the western Mediterranean Sea during winter seasons and move eastward over the basin **(Figure 6)**.

A southward (northward) propagation of rain systems is also clearly seen during the winter (spring-summer) season. These features indicate that precipitation over MB might be associated with mesoscale disturbances originate from both mid-latitudes and tropics **(Figure 7)**.

There is clear inter-annual variability of rainrates over the Mediterranean region. A number of studies have pointed out a strong relationship between North Atlantic Oscillation (NAO) and Mediterranean rainfall (see Trigo et al., 2006, Xoplaki et al., 2004). However, the last 10-year record shown in Figure 8 suggests that the relationship with NAO is not always clear. More importantly, rainfall variability over Mediterranean Sea and oversouthern Europe show different characteristics with respect to NAO **(Figure 8)**.

A detailed investigation is under way to better understand 1) year-to-year variations in the propagating rain systems and its potential relationship with NAO, and 2) moisture source(s) for these propagating systems.

References:

Homar, V., A. Jansa, J. Campins, A. Genoves, C. Ramis, 2007 : Towards a systematic climatology of sensitivities of Mediterranean high impact weather: a contribution based on intense cyclones, Natural Hazard and Erath System Science, 7, 445-454.

Lionello, P., and co-authors, 2006: Cyclones in the Mediterranean region: climatology and effects on the environment, '*Mediterranean Climate Variability*', Elsevier B.V., 325-372.

Mehta A.V. and Yang, S., 2008: Precipitation Climatology over Mediterranean Basin from TRMM, Advances in Geosciences, 17, 87-91.

Trigo, R., and co-authors, 2006: Relationship between variability in the Mediterranean region and mid-latitude variability, '*Mediterranean Climate Variability*', Elsevier B.V., 179-226.

Trigo, I. F., 2006 : Climatology and interannual variability of storm-tracks in the Euro-Atlantic sector: a comparison between ERA-40 and NCEP/NCAR reanalysis, Climate Dynamics, 26, 127-143.

Xoplaki, E., J.F. Gonzalez-Rouco, J. Luterbacher, and H. Wanner, 2004: Wet season Mediterranean precipitation variability: influence of large-scale dynamics and trends, *Climate Dynamics*, **23**, 63-78.